Electricity Storage

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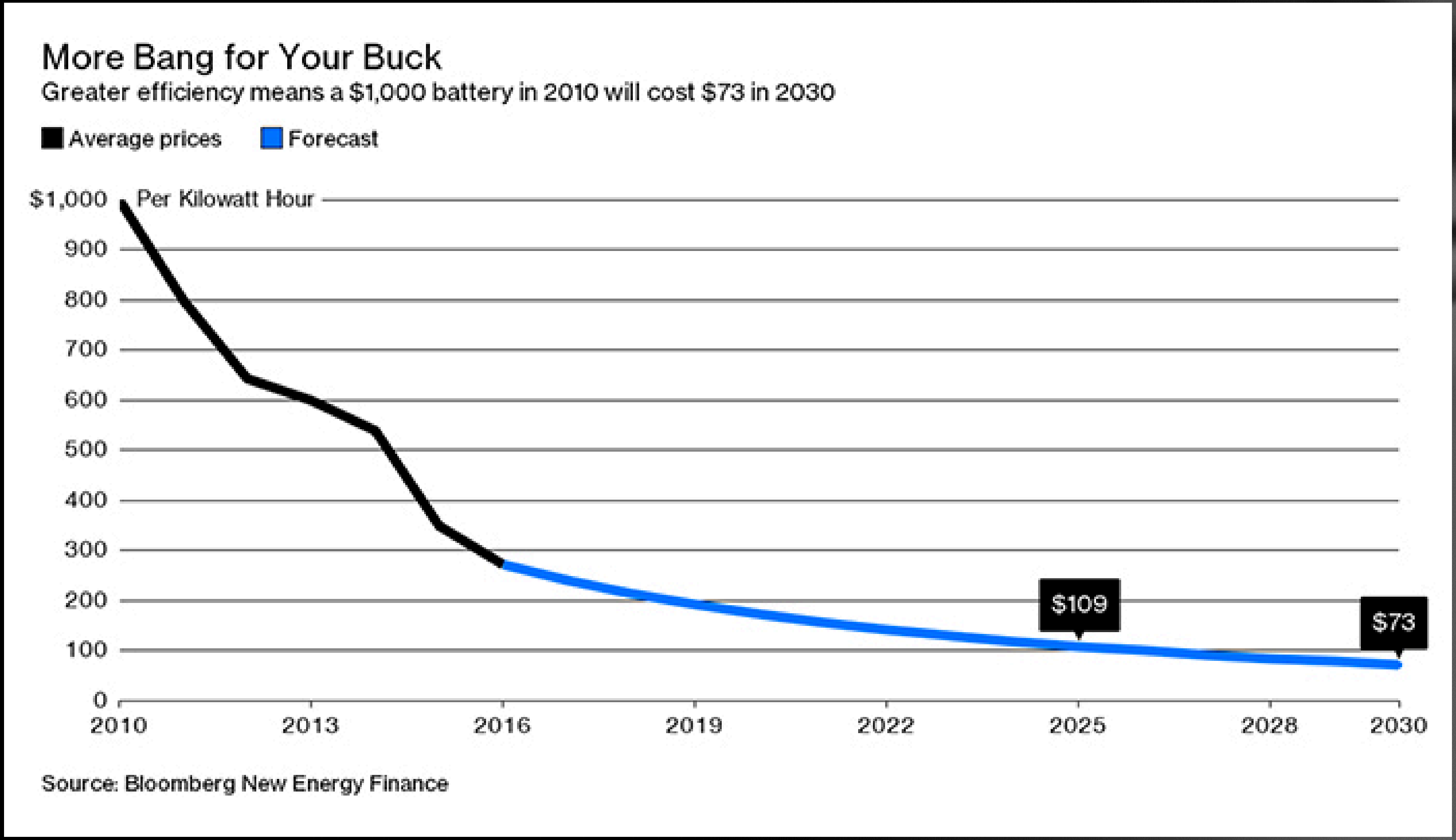
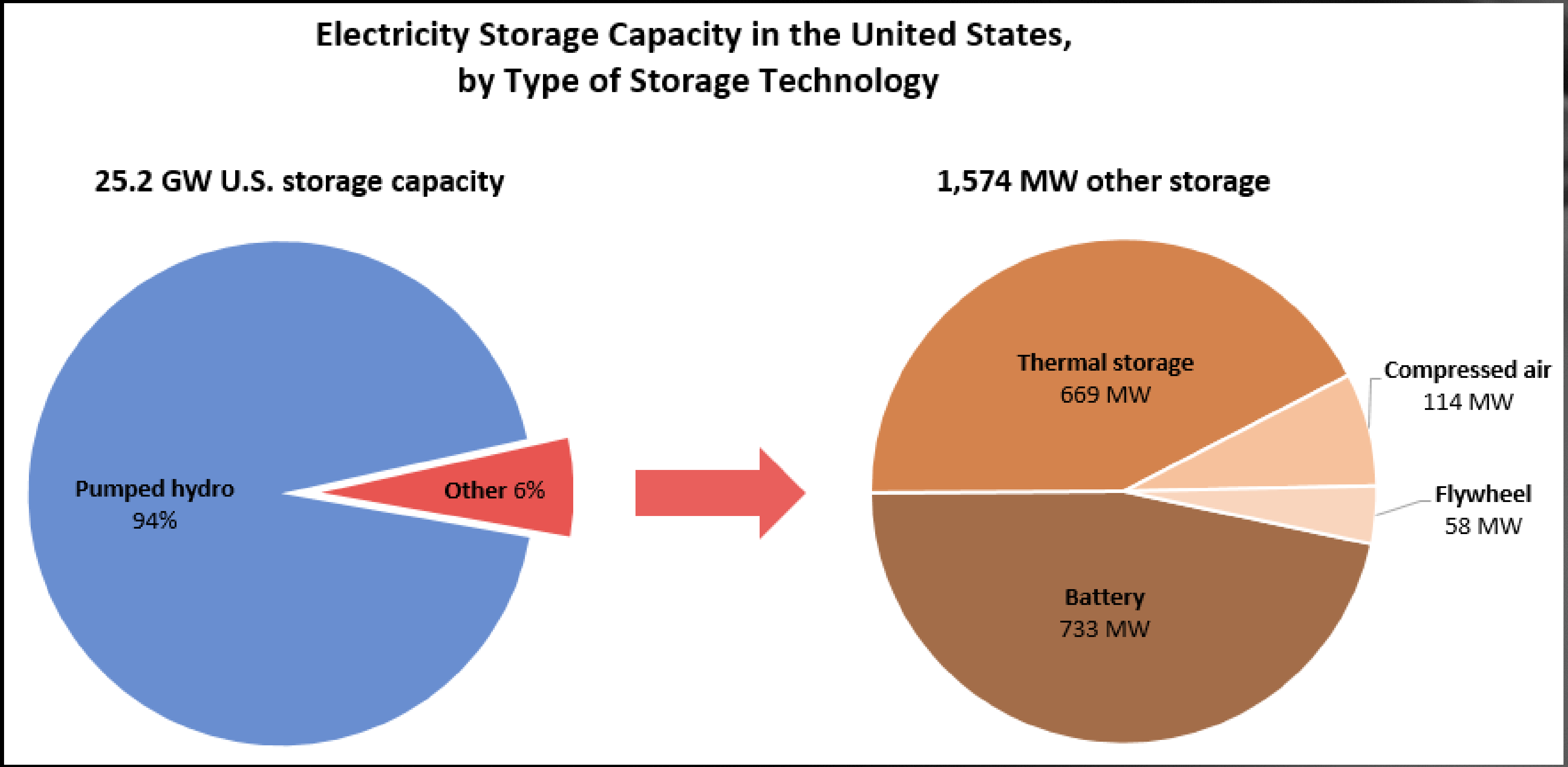
The Context

- Electricity = Just –In-Time Commodity
- Infrastructure built to deliver electricity needed to meet demand nearly instantaneously
- Grid stable at 60 Hz
- Historically: only cost effective storage = pumped hydroelectric
- Imagine a World….

Cost-Effective Batteries

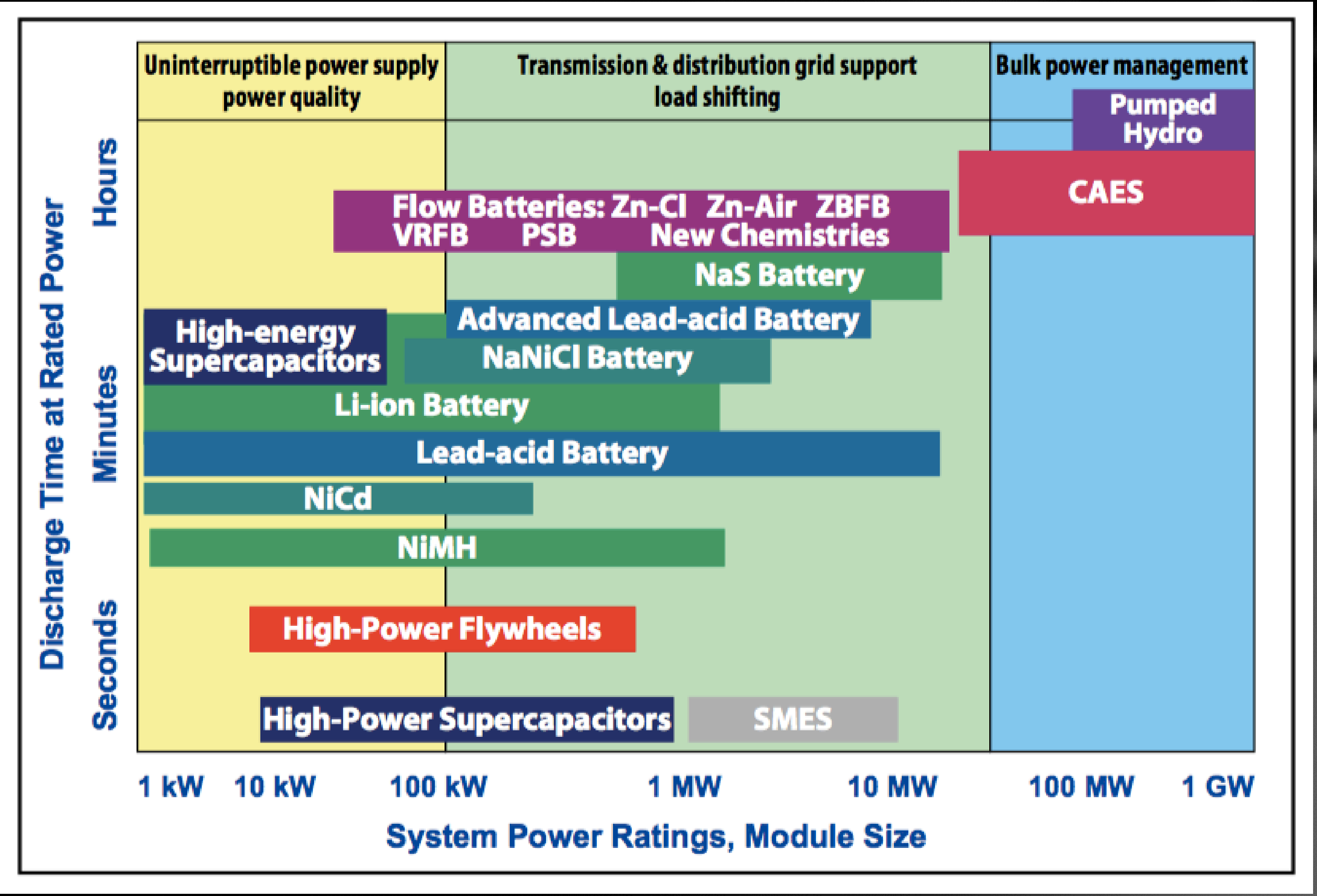


Five Major Types



Source – EPA 5/7/18 at https://www.epa.gov/sites/production/files/styles/large/public/2018-04/storage.png

Three levels: Grid, Distribution, Behind the Meter



Source: 2017 IRENA Electricity Storage and Renewables: Costs and Markets to 2030; taken from US DOE/EPRI 2015 data.

Note: Zn-Cl = zinc chlorine flow battery; Zn-Air = zinc air flow battery; ZBFB = zinc bromine flow battery; VRFB = vanadium redox flow battery; PSB= polysulfide bromine flow battery; NaS = sodium sulphur; NaNiCl = sodium nickel chloride; NiCd = nickel cadmium; NiMH = nickel–metal hydride; SMES = superconducting magnetic energy storage.

Many attributes

Provision of energy = generator

Enable low-carbon systems

Shave peak load (can be on the grid or behind the meter)

Demand reduction

Capacity = Reduce Utilities' requirements to build generators (resource adequacy)

Defer or avoid investments in distribution and transmission infrastructure

Energy arbitrage (storing when inexpensive and sell when prices are higher)

Ancillary services, e.g. fast ramping, spinning reserve, and frequency regulation

Voltage support and grid stabilization

Customer empowerment – self control and cost reduction

Enable microgrids

Increase reliability

Increase resilience

FERC: Treat Storage Fairly in Markets

- Historically:
  - storage = generation
  - storage not cost effective
- To properly price storage: monetize all dispatchable attributes (e.g. capacity, energy and ancillary services)
- Prohibited: treating storage only like a generator
- Currently: 25 GW of storage in U.S.
- Brattle (Consultant): estimates FERC Order => + 50 GW

Proposed Projects:

Utility Scale

1. Utility-Sponsored (Utility-Scale) Storage Connected to Renewables
2. Co-Owned (Utility and Customer) Storage on Customer Premises Connected to Renewables

Community or Campus Scale

3. Microgrid for Critical Dane County Governmental Facilities Connected to Renewables

1. Utility-Sponsored Utility-Scale Storage w/ Renewables

Description:

- Utility-scale storage captures renewable electricity that either cannot be consumed in real-time or could be better utilized later
- Could reduce peak load and improve efficiency of renewables
- If renewables in Dane County, could be on the distribution system and defer distribution upgrades

GHG Reduction: moderate to high if connected to renewables

Cost: likely a battery system. Cost depends on project size. Costs (and revenues) would accrue to utility and then to ratepayers.

Economic Benefits: medium to high depending on how the benefits are stacked

Feasibility: High – would require PSCW approval

Temporal Dimension: 3-4 years

Equity Considerations: Yes. Utility costs paid by customers benefitting

Co-Benefits: Moderate. Reduce need for peaking plants and their emissions

Adaptation: Yes. Very valuable, increasing reliability and resiliency

2. Co-Owned Storage on Customer Premises with Renewables

Description:

- Capture renewable electricity and use during customer peak
- Would reduce customer's peak load
- Excess electricity used by utility

GHG Reduction: moderate if the battery is a modest size

Cost: likely a battery system. Customer would likely pay for most; could utilize TIF-like structure where customer pays utility overtime thru reduced demand charges.

Economic Benefits: medium depending on how the benefits are stacked.

Feasibility: High – would require PSCW approval

Temporal Dimension: 3-4 years.

Equity Considerations: Yes. Any utility costs paid by those benefitting

Co-Benefits: Moderate. Reduce need for peaking plants and their emissions.

Adaptation: Yes. Very valuable, increasing reliability and resiliency

3. Microgrid for Critical Dane County Governmental Facilities

Description:

- Create microgrid for critical governmental facilities by combining renewables with storage. Assume a small microgrid.

GHG Reduction: low given storage size would likely be small

Cost: likely a battery system. Cost depends on project size

Economic Benefits: low to medium depending on how the benefits are stacked

Feasibility: medium – PSCW jurisdiction depends on microgrid design

Temporal Dimension: 3-4 years

Equity Considerations: Yes. If benefitting only the county, county would pay; however, federal grants may be available. If utility pays, then utility creates tariff whereby county pays over time.

Co-Benefits: High due to resilience. Small reduction in peaking plants and their emissions.

Adaptation: Yes, very valuable for resilience and reliability at the County facility.

Proposed Programs

1. Facilitate Behind-the-Meter Storage with Renewables for Commercial and Industrial Facilities

2. Encouraging Behind-the-Meter Residential Storage

1. Facilitate Behind-the-Meter Storage with Renewables for Commercial or Industrial Facilities

Description:

- County educates C&I facilities on how renewables coupled with storage saves money through reduced demand charges
- County could also facilitate coordinated procurement

GHG Reduction: low for each C&I facility, but could be moderate in the aggregate

Cost: low cost for Dane County. Presumably C&I customer pays for the storage.

Economic Benefits: Medium if widely adopted; benefits mostly accrue to C&I customer.

Feasibility: High.

Temporal Dimension: 1-3 years to get the program running.

Equity Considerations: No. Program only applies to C&I customers

Co-Benefits: Minor emissions reductions for each facility but could be significant in aggregate. If they can island from grid, increased resilience and black start.

Adaptation: in the future when customers can island from the grid.

2. Encouraging Residential Storage

Description:

- IRS letter ruling allows residential PV owners to install storage and qualify for the tax credit.

GHG Reduction: low

Cost: low cost for Dane County. Presumably customer pays for the storage.

Economic Benefits: Low for Dane County; benefits accrue to customers

Feasibility: High.

Temporal Dimension: 1-3 years to get the program running. The full 30% tax credits expire on 12/31/19 but then step down after that.

Equity Considerations: No. Program only applies to residential PV owners

Co-Benefits: Minor - Will allow for more efficient use of solar PV and reduce peak generation

Adaptation: in the future when PV owners can island from the grid.